DESTINATION: MARS

ACTIVITY PACKET

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Earth Science and Solar System Exploration Division

Houston Museum of Natural Science
Burke Baker Planetarium
Houston, Texas

About *Destination: Mars*

Contents

The lessons are designed to increase students' knowledge, awareness, and curiosity about the process of scientific exploration of Mars. As scientists look for evidence of life on Mars, they will focus much of their search in areas where volcanic heat and water interacted early in the geologic history of the planet. Two lessons in this packet on volcanoes and mapping river channels reinforce these basic geologic processes. These lessons lead directly to a set of simple activities that help students develop an understanding of the microbial life scientists will be searching for on Mars. The hands-on, interdisciplinary activities reinforce and extend important concepts within existing curricula.

Acknowledgements

This activity packet was developed by teachers working with scientists at Johnson Space Center's Earth Science and Solar System Exploration Division.

Marilyn M. Lindstrom
Planetary Scientist, NASA JSC - Office of Curator
Kathleen Mayse
Teacher, Clear Creek ISD, Houston, Texas
Linda Schrade
Teacher, Clear Creek ISD, Houston, Texas
Karen Stocco
Teacher, Pasadena ISD, Pasadena, Texas
Kay Tobola
Teacher, Clear Creek ISD, Houston, Texas
Carlton C. Allen
Planetary Scientist, Lockheed Martin
Jaclyn S. B. Allen
Scientist/Ed. Specialist, Lockheed Martin
Anita Dodson
Graphic Design, Lockheed Martin

Educational Video

The *Destination: Mars* educational video presents a useful parallel with the lessons. The 33 minute video chronicles a simulated human mission to Mars in 2018. The six astronauts narrate their exploration through "real time" log reports. *Destination: Mars* is available as an educational video from NASA CORE, Lorain County Joint Vocational School, 15181 Route 58 South, Oberlin, OH 44074, (440) 774-1051, ext. 249 or 293, Fax (440) 774-2144. It is also a multimedia planetarium program available from Spitz Inc., P. O. Box 198, Route 1, Chadds Ford, PA 19317, contact John Schran (610) 459-5200, Fax (610) 459-8330.

Internet

NASA Johnson Space Center, Office of the Curator
Lunar Rocks and Antarctic Meteorites
http://www-curator.jsc.nasa.gov/curator/curator.htm
Contains educational material and information about rocks from space.

Lunar and Planetary Institute
http://cass.jsc.nasa.gov/lpi.html
Contains educational material and Lunar and Mars images.

NASA Jet Propulsion Laboratory
Mars Global Surveyor
http://mgswww.arc.nasa.gov/index.html
Mars Pathfinder
http://www.mars.ucar.edu/default.html

Lesson One — Getting There!

Navigation and Trajectory

About This Lesson
In Activity One students represent the orbital paths of Earth and Mars through dramatic group demonstrations.

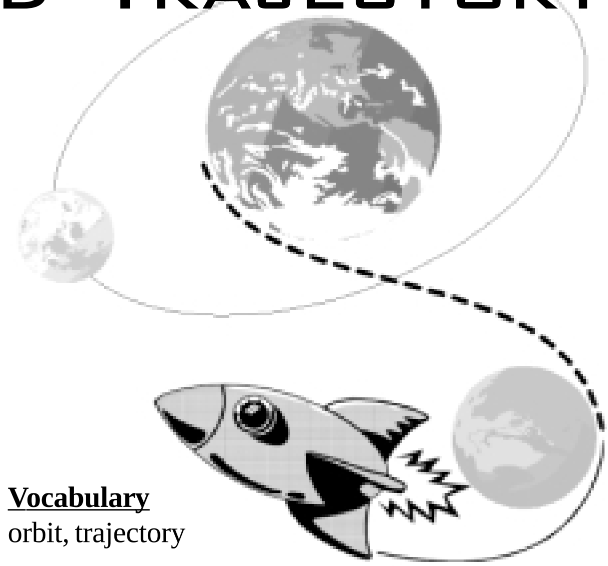
In Activity Two students working in pairs plot the paths (trajectories) of a spacecraft traveling between Earth and Mars in the year 2018 and returning in 2020. These paths use the minimum amount of fuel, and take about six months to fly from one planet to the other.

Objectives
Students will:

- consider the relationships of the planets as they move around the Sun.
- consider expenditure of time/fuel for payload in space travel.
- develop awareness of what actually happens on minimum fuel orbits.
- plot the paths of spacecraft leaving Earth in 2018 for Mars and leaving Mars in 2020 for Earth.

Background
Major considerations for traveling to Mars are the amount of time the trip takes, the amount of fuel needed for the trip, and the size of the payload. A fast trip would be advantageous to the crew by reducing the time they are exposed to weightlessness, radiation, and other dangers inherent to space travel. However, fast trips require more fuel and that means less payload. People, equipment, and supplies would be reduced as larger amounts of fuel are carried to increase the speed of the trip.

Earth and Mars move at different speeds around the Sun. The Earth completes its solar orbit every 365 days while Mars completes its orbit every 687 days. This happens for two reasons. First, the Earth is closer to the Sun so it travels less distance. Secondly, it travels faster in its orbit. Planets closer to the Sun travel faster.



Vocabulary
orbit, trajectory

Activity One —

Dancing with the Planets

Materials

- ❑ Student Procedure, *Dancing with the Planets* (pg. 7), one per group
- ❑ costume and prop materials as needed

Procedure

Advanced Preparation

1. Read background and Student Procedure. Research other sources of information as needed.
2. Gather materials.
3. Determine the time and space limitations that will best fit the learning situation.

Classroom Procedure

1. Divide the class into groups of 4-6.
2. Hand out the Student Procedure.
3. Discuss the time and space limitations for groups to consider in planning their dramatic demonstrations. Encourage the use of music, props, and choreography.
4. Allow adequate time for presentation and discussion of observations.

Activity Two —

Plotting the Paths of Spacecraft

Materials

- ❑ Student Procedure, *Plotting the Paths of Spacecraft* (pg. 8)
- ❑ Student Sheets, *Earth to Mars* and *Mars to Earth* (pgs. 9-10)
- ❑ pencils
- ❑ drawing compass
- ❑ Teacher Answer Key (pgs. 5-6)

Procedure

Advanced Preparation

1. Gather materials.
2. Review background.
3. Complete the plotting exercise for practice.

Classroom Procedure

1. Have students share familiar experiences that require aiming at a moving target. Their examples might be passing a football, catching a fly ball, driving vehicles in paths to avoid being hit, or playing dodge ball. Lead students to discuss the how and why of the movements.
2. Have students work in pairs. They may switch jobs for each plotting exercise.
3. Hand out Student Procedure and Student Sheets.
4. Help students become familiar with the data. Check for understanding. It is essential that students understand that Earth and Mars are moving and that the slashes on the Earth orbit represent the first of each month.
5. Help students plot the first date — May 11, 2018.

Note: When plotting the distance from Sun point, the compass point is always put on the Sun; when plotting the distance from Earth, the compass point is put in a different place each time. The point should be put on the slash mark that represents where the Earth will be located on that date.

5. Make answer keys available to students so they can check their work. If their orbits are not similar to the answer key, encourage them to redo the procedures to find their error.
6. Instruct students to apply the procedures to plot the return to Earth.
7. Closing discussion should encourage students to think about how a six month flight effects planning trips to Mars.

More background information is contained in the Destination: Mars Educational video. See pg. 2 to order.

Suggested Questions

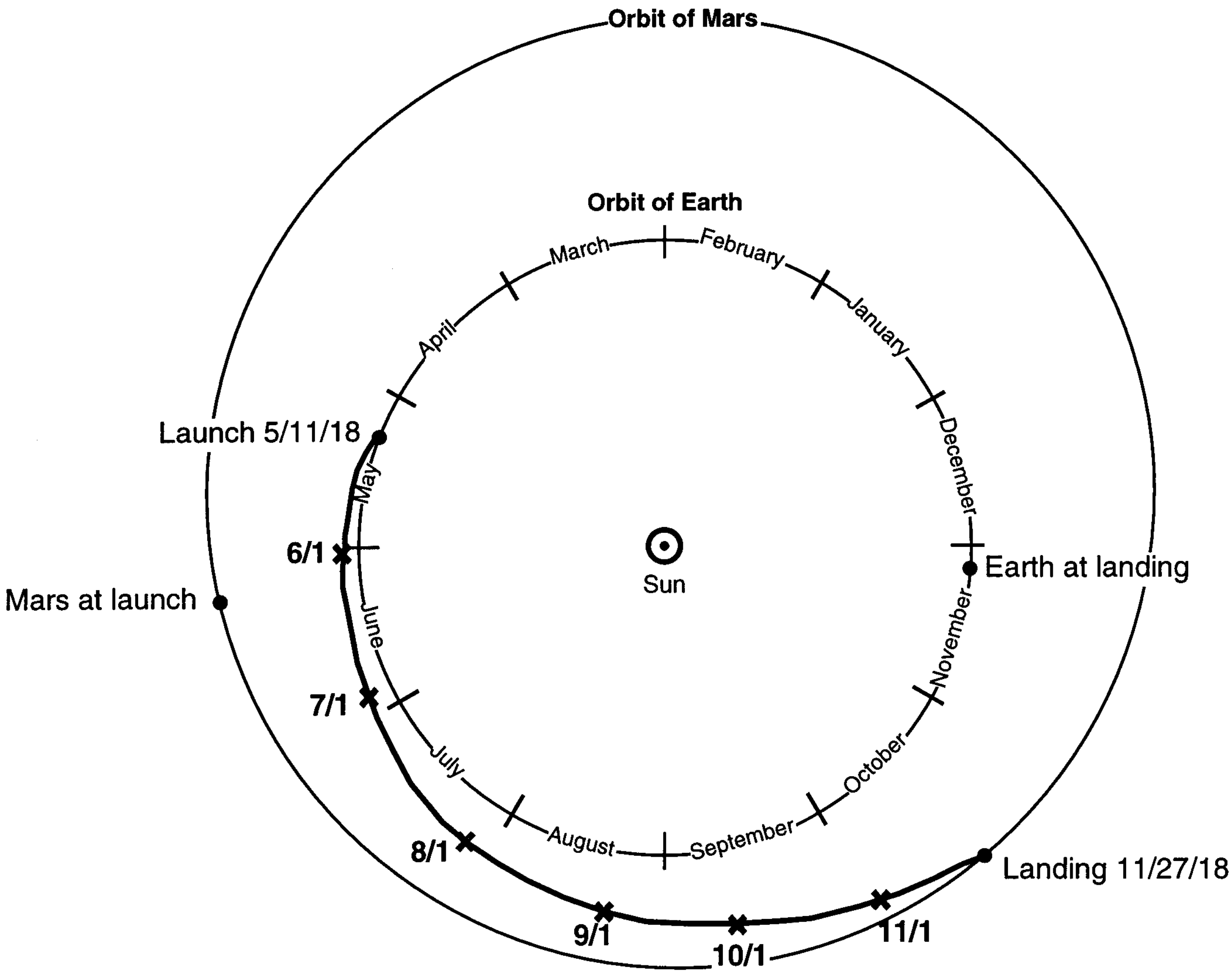
1. What are the orbital challenges of traveling from one planet to another?

2. What are some possible paths for a spacecraft traveling from Earth to Mars?

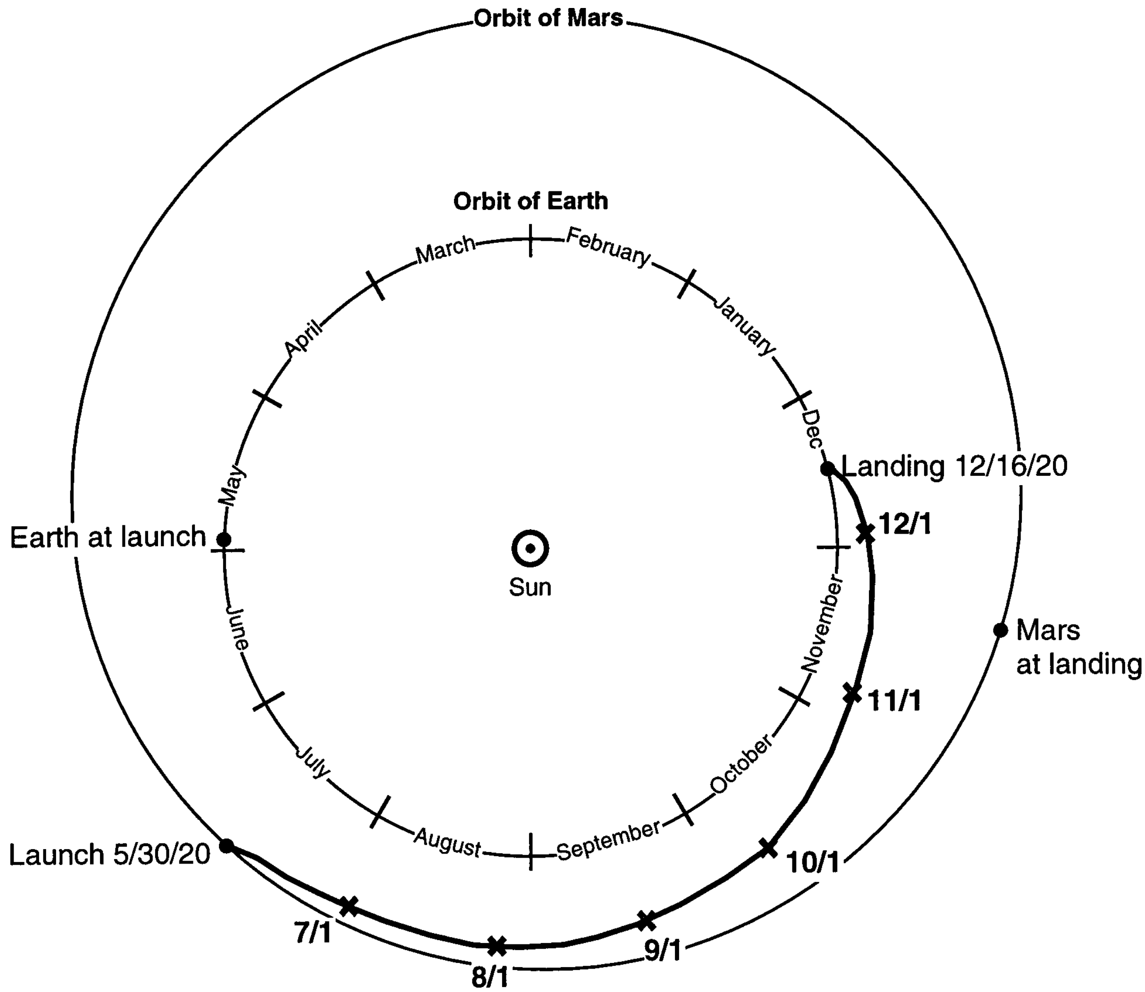
3. What could make a spacecraft get to Mars faster?

4. What are some of the problems considered by engineers and scientists as they design trips to Mars?

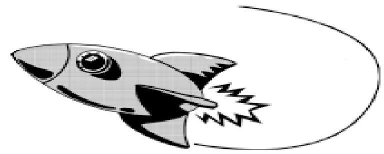
Earth to Mars
Teacher Answer Key



Mars to Earth
Teacher Answer Key



DANCING WITH THE PLANETS



Student Procedure
As scientists and engineers plan for travel to other planets, they have to deal with some basic planetary science.

- Earth and Mars move at different speeds around the Sun.
- Earth's orbit is about 150 million kilometers (km) from the Sun.
- Mars' orbit is about 200 million km from the Sun.
- Earth completes a solar orbit every 365 days.
- Mars completes a solar orbit every 687 days. (The difference in orbit times is about a 2 to 1 ratio Mars/Earth.)
- Earth completes its orbit in shorter time because it is closer to the Sun and has less distance to travel.
- Earth travels faster in its orbit. Planets closer to the Sun travel faster.

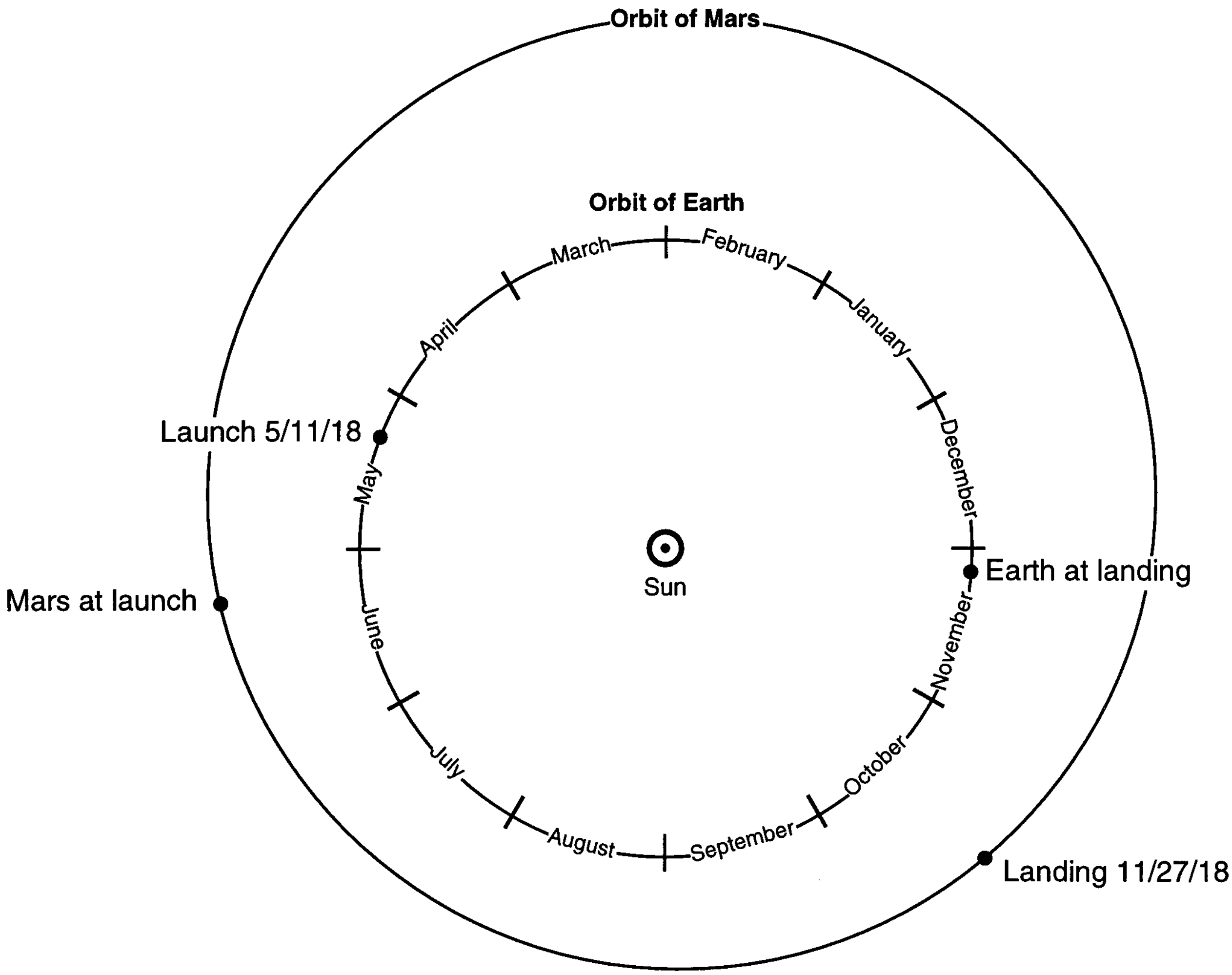
Using these facts, demonstrate dramatically the movement of Earth and Mars around the Sun. Incorporate music, costumes, and props in your demonstration for added effects. Your group may gather other information about Earth and Mars. Make your presentation scientifically accurate demonstrating as many facts as possible.

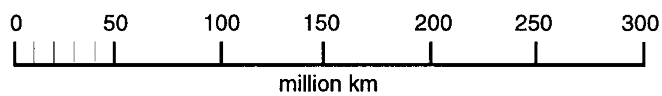
PLOTTING THE PATHS OF SPACECRAFT

Student Procedure

1. **Locate the following on the *Earth to Mars* Student Sheet;**
   - Earth and Mars orbit paths • the Sun
   - Earth and Mars on launch date • the scale in millions of kilometers(km)
   - Earth and Mars on landing date • the location of Earth on the first of each month
2. **Review the Spacecraft Position Data Table at the bottom of *Earth to Mars* Student Sheet.** The Data Table shows the position of the spacecraft on the first day of each month.
   The first column is the distances of the spacecraft from the Sun in million km.
   The second column is the distances of the spacecraft from the Earth in million km.
   Note: Remember the Earth is moving. Each month it will be in a different place.
3. **Plot the path (trajectory) of the spacecraft.**
   a. Put the point of the compass on 0 on the scale and extend the angle until the pencil reaches the first *distance from Sun* measurement given in the Data Table (152 million km). Pick up the compass and place the point on the Sun in the diagram. Line the compass up with the first date given. Strike an arc.
   b. Since the *distance from Earth* measurement is 0, the first point is where the *distance from the Sun* arc crosses Earth's orbit.
   c. Using the second set of data, measure the *distance from the Sun* (155 million km) on the scale with the compass. Place the compass point on the Sun and draw a circle. Measure the *distance from the Earth* (5 million km) on the scale with the compass. Place the point of the compass on the June 1 slash mark and draw a circle. **Notice that there are two points where the circles intersect. Choose the intersection which is closest to the launch site. This intersection represents the location of the spacecraft.** Label location with the date (June 1).
   d. Repeat this process using each set of data. Each time, the intersection that is nearer the launch site represents where the spacecraft is located on that date.
   e. Repeat these steps with each set of measurements on a given date.
   f. When all 8 points have been plotted, connect the points. This line is the path the spacecraft will follow on its trip to Mars.
4. **Using the key, check that your line is similar to the model.** If the two lines differ, find the place in the process where the error occurred. Make sure you understand the process before going to step 5.
5. **Plot the trajectory of the return trip to Earth from Mars using the second diagram and Data Table.** Follow steps 1-4.
6. **A minimum fuel trip between Earth and Mars takes about 200 days.** Think about how this effects planning trips to Mars. Because of this long time in space, what must happen? What cannot happen? What might happen? These are the questions that mission planners must answer. What are other questions that might be asked about planning trips with minimum fuel orbits?

Earth to Mars
Student Sheet



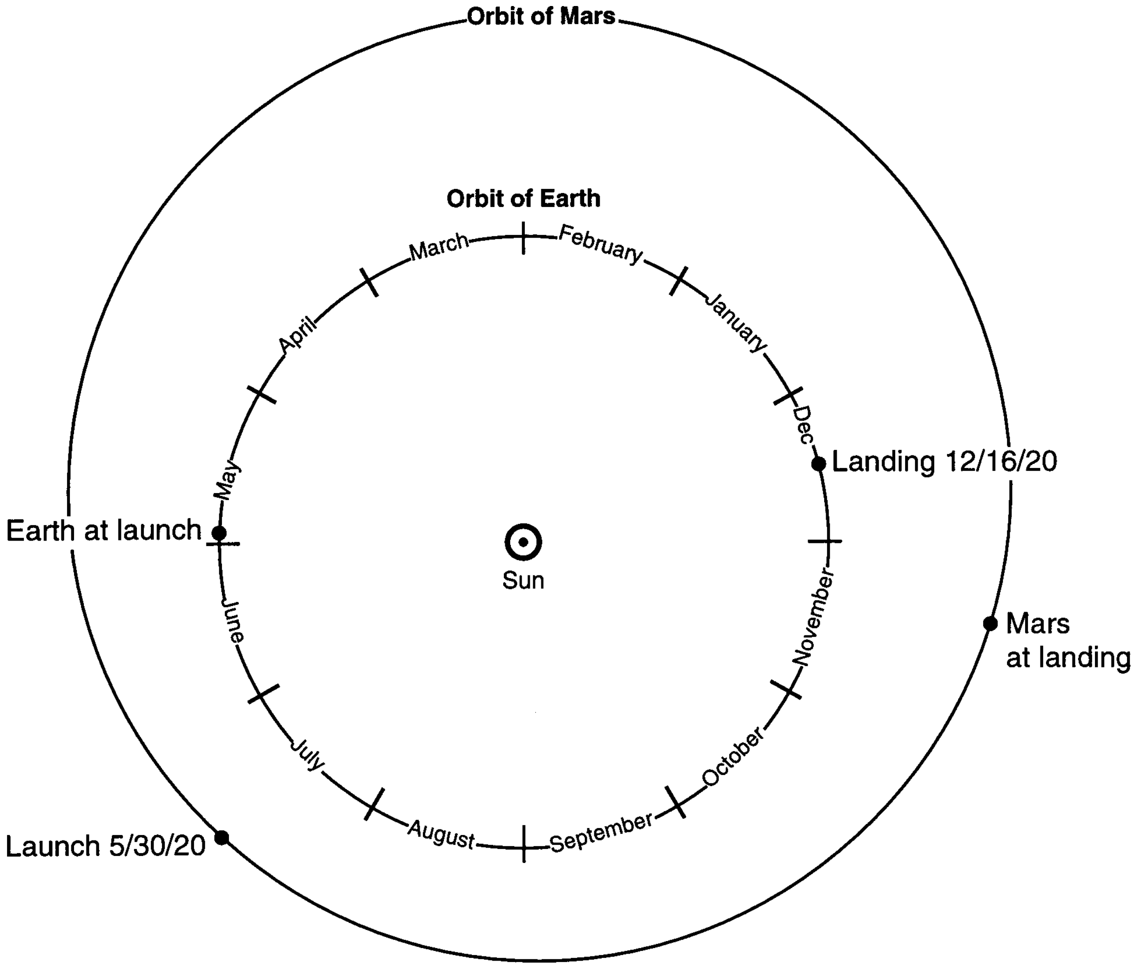


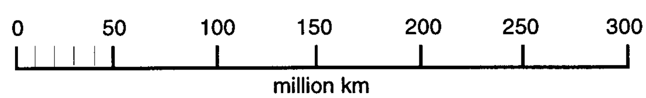
Spacecraft Position Data Table

	Date	**Distance from Sun** (million km)	**Distance from Earth on this date** (million km)	
(1)	May 11, 2018	152	0	Launch from Earth
(2)	June 1	155	5	
(3)	July 1	164	12	
(4)	Aug 1	176	25	
(5)	Sep 1	188	46	
(6)	Oct 1	199	76	
(7)	Nov 1	208	113	
(8)	Nov 27	213	147	Landing on Mars

Mars to Earth

Student Sheet





Spacecraft Position Data Table

	Date	Distance from Sun (million km)	Distance from Earth on this date (million km)	
(1)	May 30, 2020	212	153	Launch from Mars
(2)	July 1	207	115	
(3)	Aug 1	198	80	
(4)	Sep 1	187	50	
(5)	Oct 1	174	28	
(6)	Nov 1	161	14	
(7)	Dec 1	151	4	
(8)	Dec 16	148	0	Landing on Earth